Test and Training ENabling

Architecture (TENA)

TENA BASELINE PROJECT REPORT

Executive Summary

Under Secretary of Defense (Acquisition & Technology)

Director, Test, Systems Engineering and Evaluation

Office of Resources and Ranges

Central Test & Evaluation Investment Program

Pentagon (Room 3D1067)

Washington, DC 20301-3110

September, 1997

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Abstract

The Executive Summary of the TENA Baseline Project Report provides information about the Test and Training ENabling Architecture (TENA) project, including an

introduction, project background, overviews of the Product-Line Approach, requirements, architecture development efforts, the business process and TENA application concepts. We also offer an introduction to the issues and concerns about validation and transition of TENA to the Department of Defense (DoD) Test and Training national infrastructure and recommendations for future TENA-related activity based on lessons-learned from the Baseline effort.

TENA was conceived in 1995 as a tri-Service Central Test and Evaluation Investment Program (CTEIP) project. TENA responds to both long-standing and emerging challenges in the test and training communities with an architecture that enables interoperability, reuse, and sharing. TENA introduces a concept called the Logical Range. A Logical Range is a set of resources required to support a specific test or training exercise assembled into a customized system used to conduct that exercise. Resources may come from geographically distributed sites or facilities.

TENA implementations will be in the form of software-intensive systems. TENA offers an approach to building and maintaining these systems that has been proven effective elsewhere and makes sound technical and financial sense for the Test and Training communities. The Product-Line Approach (PLA) has specific advantages over current DoD project-oriented development and maintenance strategies. Development time and cost are significantly reduced using the PLA. Preliminary estimates for cost avoidance in our community range from 207 million to 1.1 billion dollars if applied to just 10 systems over the next 10 years.

TENA supports and complements radically different approaches to supporting a reengineered acquisition process such as the "Simulation, Test and Evaluation Process" (STEP). In addition to its other roles, TENA offers Continuous Insight to critical data to support informed customer and management decisions about resource needs, capabilities, and investments.

TENA offers a revolutionary response to current and expected test and training range and resource needs; however, the implementation of TENA is evolutionary. Facility managers, customers, and other stakeholders control the rate of implementation by deciding which capabilities provide the best value solutions to their needs. The TENA Transition Plan offers an approach for this evolution.

The TENA Baseline Project Report consists of 10 volumes designed for update and refinement over time. Readers are encouraged to start with this Executive Summary and the Management Overview. All volume abstracts are in Appendix A.

The opinions, ideas and recommendations presented in the TENA Baseline Project Report are the views of the TENA Project Team and do not necessarily represent those of the Sponsor.

Instructions to the Reader

The Test and Training ENabling Architecture (TENA) fiscal year 1997 Baseline Project Report contains 10 volumes and an Executive Summary. This format provides several advantages. For example, you need not read the detailed technical information in the Technical Reference Architecture (Volume IV) unless you wish. We have provided an Executive Summary which should be read by DoD range management executives and others in a decision-making role. It should also be read as a companion volume to technical volumes. The Management Overview contains enough information from the remaining technical volumes to gain a good understanding of the TENA project background, accomplishments to date, and plans for the future. Additionally, Volume IX, Glossary of Terms and Definitions and Volume X, Other Supporting Information, are intended as companion reference volumes for the reader.

Each volume contains an abstract (all are presented in an appendix to the Executive Summary), Table of Contents, Overview, Introduction, and TENA Project Background. The Overview contains information related to the specific volume, identifies the expected readership, and identifies any relationships with other volumes. The TENA Project Background is the same in each volume. Technical volumes are intended to be "stand-alone" documents that will be upgraded as more information becomes available. An acronym and reference listing, (appendices A and B in every volume) is provided, but for detailed definitions and some cited references, the reader should consult Volumes IX and X.

The TENA Project Baseline Report contains the volumes listed below:

Executive Summary

Volume I - Management Overview

Volume II - Product-Line Approach

Volume III - Requirements

Volume IV - Technical Reference Architecture

Volume IV A - Object Model

Volume IV B - Core Capabilities

Volume IV C - Standards and Protocols

Volume V - Logical Range Business Process Model

Volume VI - TENA Application Concepts

Volume VII - Integrated Validation and Verification Plan

Volume VIII - Transition Plan

Volume IX - Glossary of Terms and Definitions

Volume X - Other Supporting Information

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Purpose

This Executive Summary is designed to introduce the Test and Training ENabling Architecture (TENA) project. At a high level, we describe the project needs and our approach to satisfying those needs with the Technical Reference Architecture (TRA) [TENA, 1], the Product-Line Approach (PLA) [TENA, 2], our proposed Business Process and other supporting TENA initiatives. We introduce the Logical Range as a key application of the TENA architecture and offer recommendations for future TENA-related efforts.

Readership

This summary is intended for range management, operation directors, and others in a range management oversight or DoD and Service decision-making role. Detailed technical information is found in the supporting volumes.

Relationship to other Volumes

The Management Overview provides a more thorough introduction to TENA. Additional volumes provide detailed information on a new approach to range systems development called the Product-Line Approach, Architecture Requirements, the Technical Reference Architecture, the Logical Range Business Process Model and TENA Application Concepts, [TENA, 3] as well as information on validation, verification and transition issues. A Glossary of Terms and Definitions is provided in Volume IX. Other supporting project information and documentation is presented in Volume X. Readers are encouraged to seek additional detailed information by consulting the appropriate volume.

PROJECT NEED

TENA is part of a coordinated response by the Central Test and Evaluation Investment Program (CTEIP) office to several current and emerging challenges in the test and training range and resource community. These challenges include:

- **Reducing software development and maintenance cost,**
- **Utilizing common instrumentation at multiple facilities,**
- **Responding to the increased demand for multiple-site exercises and/or exercises which cross T&E/training or live/virtual/constructive boundaries,**
- **Responding to the increased demand for consistency of information between facilities and across phases of the acquisition process, and**
- **Capturing critical data to support informed customer and management decisions about resource needs, capabilities, and investments.**

PROJECT PURPOSE

The purpose of the TENA project is to respond to these challenges through the establishment of an architecture that efficiently and effectively fosters the sharing, reuse, and interoperability between cooperating Department of Defense (DoD) test ranges and facilities, training ranges, laboratories, and other modeling and simulation activities. The expected synergism will permit efficient and effective testing of new and enhanced weapons systems and will vastly improve the scope and fidelity of worldwide joint/combined training.

PROJECT HISTORY

The Test and Training ENabling Architecture (TENA) project concept was formulated in FY95 by a multi-Service working group. This concept was endorsed by the Test and Evaluation Reliance Investment Board (TERIB), the Board of Operating Directors (BoOD), and the Test and Evaluation Resource Council (TERC).

The Navy is the CTEIP Resource Manager for this project, and has established a Joint Project Office (JPO) for the management of project activities at the Naval Undersea Warfare Center (NUWC) Division, Newport, RI.

Shortly after assembly of the Joint Service Team, several critical observations were made:

- **The key to interoperability is not connectivity alone, but rather understanding**

communications content. This was best promoted by defining an open, object-oriented software architecture that could be used by both legacy and newly built systems.

- **The process used to plan, schedule, and otherwise coordinate a multiple-facility, multiple-service exercise must be integral to the development of the architecture, or the capabilities it offers might never be fully utilized.**

- **The architecture must be conducive to refinement over time and coexists with facility-unique applications. This requires a disciplined architecture development/refinement process. The team adapted the Defense Information Systems Agency (DISA) domain-engineering approach to help develop the architecture and recommends the Product-Line Approach for implementation and life-cycle maintenance.**

- **Significant investments are being made in other closely related areas such as, Defense Modeling and Simulation Office (DMSO), High Level Architecture (HLA) and the Joint Simulation System (JSIMS) program. TENA must leverage as many of these efforts as practical.**

- **The TENA concept is radically new to our community. Planning for transition is key to its ultimate acceptance.**

STATUS

The project team tested its architecture development process in FY96 producing a "Pilot Architecture." This work was reviewed in several public forums. These reviews were highly supportive of TENA's effort. Two consistent suggestions were that TENA should focus first "on breadth, not depth", and that there should be more emphasis on "problem-space vs. solution-space". These considerations and additional engineering effort has resulted in this refined "Baseline Architecture."

The TENA Baseline contains sufficient detail to continue further analysis and risk reduction efforts and is a good vehicle for discussion, experimentation, and refinement. It is not yet appropriate to use these documents as the blueprint for a major system development. After community feedback, results from risk-reduction prototypes, experiments, and other ongoing efforts are synthesized, the cognizant TENA Baseline documents will be updated as "TENA Rev 0." TENA Rev. 0 will be the appropriate source of design information for a TENA-compliant system implementation.

An architecture is the structure of components in a program/system, their interrelationships, and the principles and guidelines governing their design and evolution over time. [MSMP; IEEE Standard 610.12]

This TENA Baseline Report defines an architecture that will meet the needs of test and training ranges and resources well into the next century. A description of component structure (using primarily computer science) does not make a complete architecture. A complete architecture must also address the principles and guidelines governing its design and evolution over time. This Baseline Report contains both component structure and considerable guidance on the processes used to develop and refine the architecture throughout its life-cycle and manage the impact to the customer community of deploying a TENA capability.

The needs and requirements that drive TENA must come from the community it serves. Architectural features must trace to current or reasonably expected future needs. Discipline in the gathering, analysis, synthesis, review, and validation of requirements ensures an architecture meets community needs. A formal requirements process is an integral part of the TENA effort. [TENA, 4]

The methods selected to build and promulgate systems adhering to this new architecture offer tremendous opportunities to improve on current techniques, both increasing reliability, and decreasing development and maintenance costs of future systems. In order to take advantage of these opportunities we must prepare for them ahead of time, or we will fall into the "business as usual" paradigm. TENA recommends in this Baseline Report a Product-Line Approach to future system development and maintenance.

The architecture itself must allow for flexibility and modification over time. It must allow for integration with a huge investment in legacy systems while promoting incremental deployment of new features. The object-oriented, customer-focused Technical Reference Architecture offered by TENA meets these objectives.

The processes used to plan, schedule, execute, and close-out a test or training exercise are institutionalized at every major facility. A new architecture must have the flexibility to accommodate these various processes. Exercise planning and support staff must understand how to effectively use the capabilities offered by TENA. Interviews with test planners, finance staff, range users and others have led to a business process model for utilizing TENA in a way that fits with current business practices, yet offers far greater capabilities.

Each instance of the architecture, from early prototypes to full-scale implementations must be verified and validated to ensure it performs the right functions and is performing those functions correctly. TENA has generated an initial Integrated Validation and Verification (IV&V) plan [TENA, 5] to guide this effort.

The pace and place of deployment of this architecture and its capabilities into the community must be carefully planned as part of an overall transition strategy. The TENA Transition Plan identifies these issues and plans.

Each of the aforementioned concerns have been addressed as an integral and cohesive part of delivering TENA. If one area were ignored, it would significantly effect all the others. An elegant technical solution would be useless, if it were not an integral part of a well-planned support structure. On the contrary, careful consideration of the proper processes and approaches can guarantee a learning enterprise which deploys products which constantly improve over time.

TENA is fundamental to the future of test and training, yet our community may not have to bear the full burden of developing all TENA capabilities ourselves. Significant research and development effort in related architecture design is underway in many DoD and industry programs. These efforts include: the Defense Modeling and Simulations Office (DMSO) High Level Architecture (HLA), Defense Information Infrastructure-Common Operating Environment (DII-COE), Joint Technical Architecture (JTA), Joint SIMulation System (JSIMS) Architecture, Joint Tactical Combat Training System (JTCTS), Information Technology 21 (IT-21), and various commercial efforts such as the Telecommunications Information Networking Architecture (TINA).

Many of these related programs are early in their life-cycle, as is TENA. Now that we have documented a TENA Baseline, we will be able to have meaningful technical exchanges with these programs. TENA will continue to evaluate progress by these programs, and where appropriate, incorporate new developments into the TENA architecture. This may mean adapting alternative, but equally effective, technical approaches. In several instances, most notably JSIMS, there are clear areas of mutual interest and high potential for cooperative ventures. Although there are several related programs, TENA is the only project focused specifically on an architecture for Test Ranges and Resources needs.

A product line is a set of products that share common attributes (i.e., technology, design, parts, manufacturing process). Individual products may have different specific features and functionality required by different sets of customers.

Many familiar examples of product lines exist in the manufacturing and retail areas. One of these examples is the automobile, in which companies use the same engines, transmissions, frames, factory infrastructure, etc., in different models of cars which are marketed for different purposes.

Quite simply, Product-Line Approaches allow higher-quality products to be produced more quickly and with lower risk by leveraging proven components and processes. By implementing a PLA and serving 10 range sites we will save approximately $207 million in software development costs and $543 million over ten years in cumulative development and maintenance costs. [TENA, 6] These savings compare to experiential data from product-line success stories.

The major components of our community instrumentation resources (data acquisition, processing, communications, display equipment, and software) form a natural product line.

The PLA offers specific advantages over the current project-oriented development strategy. Development time and cost are significantly reduced. Products are engineered through recognition of changes within fundamental requirements or product-line architectures, rather than built from scratch. In addition, under the Product-Line Approach, the range community can provide specific guidance to suppliers for vendor qualifications, development standards, and product definitions.

The Air Force is currently planning to implement product lines, consistent with direction and guidance from DoD. A product-line strategy is consistent with and complements the ongoing acquisition reform and streamlining initiatives within the DoD and Air Force [Perry, 1994] Lightning Bolt]. Product line development was used in DoD's Software Technology for Adaptable, Reliable Systems (STARS) project. [Macala, 1996]

By exploiting commonalties and controlling the variations across related systems, the range community can develop strategies that will enable the fielding of systems faster, cheaper, and with added capability for test, evaluation, and training. However, for the product-line concept to work, there must be a fundamental change required in the way system requirements are defined, developed, deployed, and maintained.

The Product-Line Approach will result in:

- Consolidation of core resources and competencies through identification of key business areas,
- Increased quality through the use of assets that are well understood and proven through retesting during multiuse,
- Building of tailorable features into assets to meet more than one user's needs,
- Reducing overall and repetitive development costs,
- Reduction of risk in software performance through known performance of assets,
- Improved time to production through reuse of technology, design, and assets,
- Increased interoperability through reuse of common architectures, interfaces and protocols, and
- Reduced training requirements for operations and maintenance through similarities of components.

A PLA is not new to us, nor is it an "academic" solution. Its effectiveness has been proven in industry (e.g., Boeing, CelsiusTech, Hewlett-Packard, Nortel) and government (DARPA STARS project) with impressive results. [Northrop,1997] [Brownsword, 1996] There are also ample lessons learned about when and how *not to pursue* a PLA. Volume II contains detailed information about the Product-Line Approach. Recommendations for the test and training transition to a PLA are presented in Volume VIII.

An architecture is a collection of design decisions about the structure or coordination of a system. Those decisions act as constraints on the further design and implementation of the system. The architect's challenge is to make sure that the right set of decisions has been incorporated into the architecture, yet to incorporate a minimal set to prevent designers from being excessively constrained and precluding innovation.

A Technical Reference Architecture (TRA) is an abstract architecture that provides the structure and coordination capabilities that form the essential foundation around which specific system implementations are built. The approach is a hierarchical one. As shown in Figure 1, a TRA imposes a structure that will be inherited by all future system architectures (such as those for OARs, ISTFs, HITLs or other facilities). These system (or domain-level) architectures are then used to develop specific implementations at distributed test and training ranges and resources. An example expansion of the TRA into the domain of open-air ranges is included in this Baseline Report. The TRA spans all participating systems, thereby ensuring a framework for interoperability, reuse, and sharing both across and within domains.

The definition of the TENA Technical Reference Architecture describes the foundation upon which all TENA-compliant systems will operate. It defines:

- The component parts (assets) from which a system is constructed (Object Model) and the relationships between them,
- The capabilities provided to manage system components, conduct an exercise, and share data (TENA Core capabilities),
- Agreed upon conventions about data representation, communications methods, platform

support tools and capabilities, and processes among the facilities and component implementations (Standards and Protocols).

The TENA TRA is applicable to both new facilities and to existing systems that will migrate toward TENA compliance in a planned step-by-step manner.

The Logical Range Business Process Model (LRBPM) outlines the steps required to define, schedule, plan, execute, and close-out a test or training exercise in the TENA environment. In defining this model, the TENA Project utilized information from selected test and training ranges as well as industry groups (Range Joint Program Office, Range Commanders Council (RCC), and the Common Test and Training Range Architecture (CTTRA)) to address key business process issues. Our interest is to ensure that the architecture is able to support business functions so that TENA-compliant systems will be easy to use. We identify issues that facility users, e.g., acquisition managers, training coordinators, test directors, etc., will need to address in the multi-site/Service TENA environment.

A Baseline LRBPM has been developed and is presented in Volume V. The Process is customer-focused and designed to establish requirements for an exercise, select a scenario and then choose and schedule resources in order to execute the scenario. The process also provides for establishing cost information and determining data product requirements. The process shows great potential for automation using a Web-like browser and automated scheduling tools.

TENA is constructed to meet several primary needs. The TENA Background discussion presents five project needs**:**

- Reducing software development and maintenance cost,
- Utilizing common instrumentation at multiple facilities,
- Responding to the increased demand for multiple-site exercises and/or exercises which cross T&E/Training or live/virtual/constructive boundaries,
- Responding to the increased demand for consistency of information between facilities and across phases of the acquisition process, and
- Capturing critical data to support informed customer and management decisions about resource needs, capabilities, and investments.

Different elements of the architecture work together to meet one or more of these needs. Descriptions of each architectural element, although they may include examples, are not intended to show how all elements work together to respond to major tasks. An

Application Concept is the name given to a group of methods or procedures which show how to use architecture components to solve primary customer needs. TENA defines three application concepts with this Baseline Report.

- The *Logical Range Application Concept* shows how the object model structure and the Logical Range Business Process Model work together to respond to the increased demand for multiple-site exercises and/or exercises which cross T&E/training or live/virtual/constructive boundaries.

- The *Systematic Reuse Application Concept* shows how the Product Line Approach and object-oriented Technical Reference Architecture reduce software development and maintenance cost, support utilization of common instrumentation at multiple facilities, and respond to the increased demand for consistency of information between facilities.

- The *Continuous Insight Application Concept* shows how the customer focused object structure, together with the Logical Range Application Concept, allows for consistency of information across phases of the acquisition process and capturing critical data to support informed customer and management decisions about resource needs, capabilities, and investments. [Kaminski, 1995]

Together, the TENA Application Concepts cover all TENA primary needs. The Logical Range Application Concept is explained in detail in the Volume VI. Expository information on other application concepts, including an explanation of how the Continuous Insight concept supports the STEP process will be added to subsequent releases of Volume VI.

This Integrated Validation and Verification (IV&V) Plan addresses Validation and Verification (V&V) throughout the life cycle of TENA products. It covers the conceptual design, known as the Technical Reference Architecture (TRA), prototypes, and the installed system capability. Planned validation activities are divided into phases as follows:

- Phase I - Verification of Technical Architecture against requirements for the architecture. This will be performed analytically.

- Phase II - Verification of System Architectures against requirements for range instances. This will be performed through prototypes to test architectural elements.

- Phase III - Validation of implementation against range operator expectations and actual test plans. This will include integration and acceptance testing.

- Phase IV - Installation of the operational system.

The schedule for these phases will span the development and Initial Operational Capacity (IOC) testing of ranges constructed using TENA products. TENA has used DoD guidelines to tailor an Integrated Validation and Verification Plan for TENA. This plan is presented in Volume VII of the TENA Baseline Project Report.

Several scenarios have been developed for use in the IV&V effort. A sample scenario is presented in the Management Overview (Volume 1) and all eight scenarios are contained in the appendix of the IV&V plan.

Widespread acceptance of the TENA project by all of its users and customers is necessary to ensure project success. The TENA user community is extremely broad in scope including acquisition program managers in traditional T&E roles, operational testers, test and training ranges and facilities, operational service/joint commands, industry and academia. The TENA Project team has established close liaison with the RCC, CTTRA Group, and the TERIB. Recently, we have initiated discussions with Training Instrumentation Resource Investment Committee (TIRIC) staff to improve communication with the training range community. Liaison with these groups and others support key relationships that will help with the acceptance and transition of TENA to the services.

The Product-Line Approach will form the basis of the methodology for transition of TENA and will provide the organization necessary to maintain and upgrade the architecture. Deployment methods for the architecture and software upgrades will be developed using the PLA.

TENA is at the end of the second year of a proposed five-year transition plan. This Baseline report delivers the current Technical Reference Architecture. FY98 will focus on engineering level testing of selected portions of the domain-specific architecture for Open Air Ranges and operations with Installed System Test Facilities. The project plans operational-level testing parallel with existing range operations in FY99 and finally, in the year 2000, one or more instances of TENA will become primary operational systems and the life-cycle support of TENA will be transferred from its current CTEIP line into its permanent home. Upgrades to the Baseline Architecture are planned to be released at least once a year.

TENA is part of a total test improvement program initiative underway in the CTEIP program office. The entire scope of this initiative is likely to involve multiple cooperating projects. TENA's object-oriented architecture and Product-Line Approach is the foundation for a more cost-effective test and training capability so that we will continue to provide superior U.S. defense forces into the 21st century.

CREATE A TENA CHAMPION

TENA Application Concepts (Logical Range, Systematic Reuse, Continuous Insight) will not be realized by creating a set of loosely related programs that attack selected specific (or overlapping) aspects of the problem. What is required is a systems perspective and a comprehensive plan that identifies all of the measures necessary for success and the means of insuring their accomplishment. The champion must be the owner of this plan and animate available resources in concert with each other and according to plan. The architecture is the key element in that plan, but not the only one.

Providing for the existence of an architecture is not enough to insure that useful products will result. It takes a concerted, well-coordinated effort to overcome technical, cultural, political, and programmatic obstacles. The Champion must be at a level where the direction and marshaling of resources can drive the Product Line Approach, and that level is Director, Defense Test, Systems Engineering, and Evaluation (DTSE&E).

INVEST MODEST, SUSTAINABLE RESOURCES TOWARD TENA REALIZATION

TENA is a revolutionary approach to resolving long-standing test and training community challenges. All industries have a limit on how quickly change can be effectively managed and implemented. The Test and Training Range and Resource community is no exception.

The perception that more than 100 million dollars would be invested in CTEIP "Visionary" or "Foundation" projects over the next few years has been largely counterproductive to their community acceptance. Potential customers do not yet fully understand the projects nor have they seen a "master plan". They are understandably reluctant to fully support visionary projects, given their own short-term fiscal pressures. The potential availability of tens of millions of dollars has too often paralyzed start-up visionary projects with discussions over how to allocate funding to the detriment of delivering useful products.

TENA recommends a modest, sustainable investment of between $3 - $5 million per year in projects dedicated to TENA review, prototyping, refinement, and transition. This level of funding is sufficient to make significant incremental progress, and modest enough to avoid many territorial issues. As progress is demonstrated (or fails to be demonstrated) the appropriate investment level can be reviewed.

INCREASE OUTREACH ACTIVITIES TO OTHER RELATED PROJECTS

At least four major programs are developing object-oriented and/or HLA compatible distributed systems to support other DoD needs: Command Staff Training (JSIMS), Campaign Analysis (JWARS), Tactical Air Combat Ranges (JTCTS), and Composing simulations (JMASS). Commercial activity in areas closely associated with TENA include the Simulation Interoperability Services Organization (SISO) and the Telecommunications Information Networking Architecture (TINA).

The Baseline Architecture and subsequent updates, can serve as a reference point for discussion with other communities to determine alternative approaches or the suitability of cooperative efforts. This is important for three reasons:

- There is no need for the CTEIP office to bear the full burden of implementing TENA technologies. There are ample lessons-learned in DoD and closely-related commercial applications to avoid the cost penalty of being "an early adaptor".
- The high potential for, and payback of, common components across problem domains (such as a common presentation system) , and
- The need to interoperate not just within test and training ranges and resources, but also with other DoD and commercial exercise participants in the greater Joint Synthetic Battlespace.

CONTINUE SELECTED TECHNICAL ACTIVITIES

While organizational and/or programmatic options are being considered, the progress of the technical team must not be interrupted. Leave this team intact to pursue near-term technical activities including:

- Industry Review - Early and wide review of the TENA Baseline will allow incorporation of community concerns while it is still relatively simple to make key design changes.
- Risk Reduction - Certain features or functions are critical to the remainder of the architecture. These include the CORE/HLA services, Information Presenter, and Communication elements. These should be modeled and/or prototyped as early as possible to verify basic architectural assumptions.
- Integrated Validation and Verification - Phase I of the Integrated Validation and Verification Plan examines the architecture by analysis of scenarios (use cases). This effort can proceed almost immediately. It will likely identify the need for additional object classes, methods, and attributes or other architectural refinement.
- Architecture Refinement - As a result of risk reduction efforts, Phase I Integrated V&V, and continuation of activities already planned, the Baseline definition will be updated prior to any attempt to build a full capability TENA system.
- Transition Preparation - It will take time to build awareness of TENA Transition issues in the large stakeholder population. We will not be prepared for transition out of the CTEIP funding line, or establishment of the Product Line Approach if we don’t start now.
- Coordination - Technical exchanges with other related projects, will, like industry review, allow us to make architectural changes to accommodate better interoperability or reuse while it is still relatively easy to do so. We may find substantial cost savings in lessons-learned or pursuit of cooperative development efforts.

Volume IX of the TENA Baseline Report contains the detailed Glossary of Terms and Definitions. This volume should be available when reading this Executive Summary or any of the technical volumes. One criticism of the test community, in particular, is the failure to use a standard lexicon. The standard for DoD is JCS Pub 1-02. That publication and other references are used throughout the TENA Baseline Project Report to develop the Glossary found in Volume IX. Volume X contains various reports and documents related to the overall project. These are research efforts, procedural and documentation guides, and other studies that support the development of the project or project deliverables.

AFFTC Air Force Flight Test Center

BoOD Board of Operating Directors

BPR Business Process Reengineering

C4I Command, Control, Communications, Computers & Intelligence

CDAPS Common Display and Analysis Program

CINC Commander-in-Chief

COE Common Operating Environment

COTS Commercial-off-the-Shelf

CTEIP Central Test and Evaluation Investment Program

CTTRA Common Test and Training Range Architecture

DII Defense Information Infrastructure

DISA Defense Information Systems Agency

DMSO Defense Modeling and Simulation Office

DoD Department of Defense

DTEC Defense T&E Complex

DTTSG Defense Test and Training Steering Group

DTSE&E Director, Defense Test, Systems Engineering, and Evaluation

HITL Hardware-in-the-Loop

HLA High Level Architecture

HWIL Hardware-in-the-Loop

ISTF Installed System Test Facility

IT-21 Information Technology--Twenty-First Century

IV&V Integrated Validation and Verification

JCS Joint Chiefs of Staff

JIM Joint Improvement and Modernization

JMASS Joint Modeling and Simulation System

JPO(T&E) Joint Project Office (Test and Evaluation)

JRRC Joint Regional Range Complex

JSIMS Joint Simulation System

JTA Joint Technical Architecture

JTCTS Joint Tactical Combat Training System

JTTRR Joint Test and Training Range Roadmap

JWARS Joint Warfare Simulation

LFT&E Live Fire Test and Evaluation

LRBPM Logical Range Business Process Model

M&SMP Modeling and Simulation Master Plan

MAIS Major Automated Information Systems

MDAP Major Defense Acquisition Programs

MRTFB Major Range & Test Facility Base

NUWC Naval Underwater Warfare Center

OM Object Model

OSD Office of the Secretary of Defense

OT&E Operational Test and Evaluation

PDUSD(A&T) Principal Deputy Undersecretary of Defense (Acquisition & Technology

PE Program Element

PLA Product-Line Approach

RCC Range Commanders Council

RDT&E Research, Development, Test & Evaluation

SAAM Software Architecture Analysis Method

SEI Software Engineering Institute

SETI Synthetic Environment Training Initiative

STARS Software Technology for Adaptable Reliable Systems

STEP Simulation, Test and Evaluation Process

SWIL Software-in-the-Loop

T&E Test and Evaluation

TEMS Test & Evaluation Modeling & Simulation

TENA Test and Training ENabling Architecture

TERC Test and Evaluation Resource Committee

TERIB Test and Evaluation Reliance Investment Board

TFR Test Facility Resources

TINA Telecommunications Information Networking Architecture

TIRIC Training Instrumentation Resource Investment Committee

TRA Technical Reference Architecture

USD(A&T) Under Secretary of Defense (Acquisition & Technology)

VTTR Virtual Test and Training Range

TENA Baseline Project Report Abstracts

Volume I - Management Overview

The Management Overview provides high-level summary information designed to familiarize the reader with the overall Test and Training ENabling Architecture (TENA) project. The major points of the various technical volumes in the TENA Baseline Project Report are presented in abbreviated form in this Management Overview. It includes important concepts, processes, conclusions, and recommendations at the level of a comprehensive overview. Readers should consult other volumes to gain an in-depth understanding of each topic.

The Management Overview also serves as an expansion of key concepts given in the

Executive Summary. These include:

- The Logical Range--a set of resources required to support a specific test or training exercise assembled into a customized system used to conduct that exercise. Resources may come from geographically distributed sites or facilities.

- The Product Line Approach--TENA implementations will be in the form of software-intensive systems. TENA offers a Product Line Approach to building and maintaining these systems that has been proven effective elsewhere and makes sound technical and financial sense for the test and training communities. Preliminary estimates for cost avoidance in our community range from $207 million to $1.1 billion if applied to just 10 systems over the next 10 years. The TENA Cost Study which derived these estimates is contained in Appendix D.

- Continuous Insight--TENA supports and complements radically different approaches to supporting a reengineered acquisition process such as the "Simulation, Test and Evaluation Process" (STEP). In addition to its other roles, TENA offers Continuous Insight to critical data to support informed customer and management decisions about resource needs, capabilities, and investments.

- Evolutionary Implementation--TENA offers a revolutionary response to current and expected test and training range and resource needs; however, the implementation of TENA is evolutionary. Facility managers, customers, and other stakeholders control the rate of implementation by deciding which capabilities provide the best value solutions to their needs. The TENA Transition Plan offers an approach for this evolution.

This Management Overview also discusses lessons-learned from the two-year TENA effort and offers recommendations based on those lessons. The recommendations supplement and/or expand those given in the Executive Summary.

The Management Overview of the TENA Baseline Project Report provides high-level summary information designed to familiarize the reader with the overall Test and Training ENabling Architecture (TENA) project, including project background, objectives, requirements, and description of the architecture development effort. TENA introduces two new concepts this year: the Product-Line Approach and the Logical Range. A TENA-compliant Business Process for the Logical Range and a Concept of Operations are also provided. The draft Transition Plan provides an introduction to the issues and concerns about transition of the TENA to the Department of Defense (DoD) Test and Training national infrastructure.

TENA was conceived in 1995 as a tri-service project and during the interim has become a foundation project of the Central Test and Evaluation Investment Program (CTEIP). The TENA Architecture will become the foundation for answering important challenges and achieving certain goals and objectives of the Test and Training Communities. Three critical objectives of this architecture are: interoperability, reuse, and sharing. A method for enabling TENA objectives is the Logical Range. A Logical Range is a set of assets required to conduct a specific test exercise or training event logically assembled into a system used to conduct that exercise or event. The assets may come from one or more facilities.

Radically different approaches are needed to continue to meet the demand for increased software functionality at a time when DoD has less money and staff to accomplish the task. One such approach, the Product-Line Approach (PLA), makes sound technical and financial sense for the Test and Training communities. The Product-Line Approach offers specific advantages over the current project-oriented development strategy. Development time and cost are significantly reduced. Products are engineered through recognition of changes within fundamental requirements or product line architectures, rather than built from scratch. In addition, under the PLA, the range community can provide specific guidance to suppliers for vendor qualifications, development standards, and product definitions.

Finally, a Business Process is presented for operating a Logical Range and the Transition Plan develops some of the concerns and expectations for implementing a new way for

DoD ranges to conduct business—the Product-Line Approach.

Volume II - Product-Line Approach

The Test and Training ENabling Architecture (TENA) Product-Line Approach (PLA) presents a Cooperative Methodology for Supporting Test and Training Resources and Ranges. The PLA is fundamental and essential to engendering the cost savings required of DoD ranges in the future, but also to breaking the paradigms of the present. The TENA Architecture will provide significant cost savings through interoperability, reuse and sharing, but the true breakthrough or revolution in the business approach to range systems development can only be realized through a fundamental shift in the way we design, develop, deploy and maintain these systems. That revolution is called the Product-Line Approach.

Radically different approaches are needed to meet the demand for increased software functionality, at a time when DoD has less money and staff to accomplish the task. One such approach; the Product-Line Approach (PLA), makes sound technical and financial sense for the Test and Training communities. The Product-Line Approach offers specific advantages over the current project-oriented development strategy. Development time and cost are significantly reduced. Products are engineered through recognition of changes within fundamental requirements or product line architectures, rather than built from scratch. In addition, under the PLA, the range community can provide specific guidance to suppliers for vendor qualifications, development standards, and product definitions. {insert item on cost savings}

This document describes the Product-Line Approach and defines the organizations required to implement it and the processes used by those organizations. The application to ranges is intuitive, but will require additional research to establish the best organization and processes.

The intent of this volume is to introduce and discuss the concepts required to understand the PLA. It is not intended to be an implementation or transition plan. It does not provide managers with the detailed steps involved in planning for the transition, including establishing accountability, managing risk, scheduling, and budgeting. However, it does offer a clear methodology to realizing the goals and objectives of the highest levels of DoD for modernizing our test and training infrastructure.

The Test and Training ENabling Architecture (TENA) Product-Line Approach (PLA) presents a Cooperative Methodology for Supporting Test and Training Resources and Ranges. The PLA is fundamental to engendering the cost savings required of DoD ranges in the future, and breaking the paradigms of the present. The TENA Architecture will provide significant cost savings through interoperability, reuse, and sharing, but the true breakthrough or revolution in the effectiveness and economics of test and training ranges and resources can only be realized through a fundamental shift in the way we design, develop, deploy, and maintain these systems. That revolution is called the Product-Line Approach.

Radically different techniques are needed to meet the demand for increased software functionality, at a time when DoD has less money and staff to accomplish the task. The Product-Line Approach (PLA), makes sound technical and financial sense for the Test and Training communities. The Product-Line Approach offers specific advantages over the current project-oriented development strategy. Development time and cost are significantly reduced. Products are engineered through recognition of changes within fundamental requirements or product-line architectures, rather than built from scratch. In addition, under the PLA, the range community can provide specific guidance to suppliers for vendor qualifications, development standards, and product definitions.

By implementing a PLA and serving 10 range sites we will save at least 207 million dollars in software development costs and 543 million dollars over ten years in cumulative development and maintenance cost. These savings compare to experiential data from product-line success stories.

This document describes the Product-Line Approach and defines the organizations required to implement it and the processes used by those organizations. The application to ranges is intuitive, but will require additional research to establish the best organization and processes.

An incremental, evolutionary transition to a Product-Line Approach is recommended as an integral part of TENA's response to realizing the goals and objectives at the highest levels of DoD for modernizing our test and training infrastructure.

Volume III - Requirements

The requirements portion of the TENA project is a process-driven effort, based on the Domain Engineering process. TENA Requirements are organized into three "tiers": Technical Reference Architecture (TRA) Requirements, Domain (or System) Requirements and Base (or Implementation) Requirements.

- TRA Requirements are common to all TENA-compliant systems.
- Domain Requirements are common to a group of TENA-compliant systems. Potential domains include Open-Air Ranges (OARs), Installed System Test Facilities (ISTFs), Measurement Facilities (MFs), and other major categories of test and training resources.
- Base Requirements are requirements for individual instances of the architecture. TENA has defined five types of Base Requirements. Legacy requirements, derived directly from existing system documentation or from analysis of existing systems, are a primary source of Base Requirements. Visionary requirements are developed from scenarios of likely future uses of TENA. The Logical-Range-Business Process Model generates Business

Process requirements. Additionally, there are issues unique to Communications/Networking and requirements derived from other Related Architectures.

TRA Requirements are synthesized from Domain Requirements, and Domain Requirements are synthesized from Base Requirements

TRA Requirements are traced to elements of the architecture. This mapping shows which architectural elements are responsible for meeting documented needs. A similar process would be used at the Domain and Implementation Levels prior to deploying a TENA-compliant system.

This Requirements Volume documents the TENA Requirements Engineering Process, TRA Requirements, example requirements for the OAR domain, and provides a traceability matrix relating these requirements to architectural elements.

The TENA Requirements Volume presents the baseline set overall domain level portion of the project is a multi-tiered, process-driven effort. TENA requirements span the system life cycle, from legacy requirements to visionary requirements. Legacy requirements are analyzed and used as a baseline to identify near-term TENA capabilities. These near-term capabilities are then synthesized into TENA domain requirements. Visionary requirements are developed to address future TENA capabilities. Allowing such a broad range of requirements adds to TENA's complexity, but preserves the existing range infrastructure investment. Synergy among the various tiers of requirements is maintained by following a well-defined requirements engineering process.

The requirements engineering process has evolved throughout the TENA development activity. In the refined version of the process, requirements are organized around a specific set of architectures. This set of architectures includes an Operational Architecture, a Systems Architecture, and a Technical Architecture. An identical set of architectures is identified by the Joint Technical Architecture. However, the TENA Requirements Engineering process identifies additional architectures (e.g., a Systems Implementation Architecture), architectural views, and rationales for linking architectures, views, and requirements. The set of architectures, coupled with requirements and rationale, provides a working (i.e., scaleable and extendible) specification for TENA. More specific information regarding the set of architectures, TENA Requirements, and the requirements engineering process can be found in Volume V.

Volume IV - Technical Reference Architecture

Volume III A - Object Model

Volume III B - Core Capabilities

Volume III C - Standards and Protocols

The purpose of TENA is to affordably and effectively utilize processes and technologies to enable sharing, reuse and interoperability between test and training ranges and resources. This document describes the TENA architecture that will support this purpose.

An architecture is a fundamental and important part of a development approach, which supports reusability of components and the interoperation of diverse systems distributed over multiple platforms and facilities. Development experience has shown the utility of basing architecture upon a Technical Reference Architecture (TRA), in particular in systems where a number of facilities that perform different functions must standardize their implementations to achieve goals such as those that TENA is striving for. The TRA is the mechanism to insure that basic system level requirements critical to interoperability, composability, and reuse are satisfied even when applied to a number of different system architectures. TENA is based on the concept of definition of a TRA that is instantiated as needed to form the core infrastructure for system architectures that serve different T&E and training facilities. The TENA TRA is composed of an Object Model, a TENA Core, and Standards and Protocols. Each of theses are presented in a format most amenable to a clear understanding of their function.

The Object Model represents several views of reality (Test and Training Ranges) that are recognizable and meaningful to range users. The view presented here is primarily a structural model. The TENA Object Model is composed of Classes and the Methods that are available to manipulate or use instances of those classes. In their totality, they comprise the pieces from which a logical range is constructed. The Model is presented in a hierarchical graphical structure accompanied by clarifying text. We have concentrated more on open-air ranges in the initial analysis because of availability of information and cognizant personnel. As we proceed the analysis will extend across the entirety of the domain of T&E and training facilities.

The TENA Core capabilities provide a means for range components to communicate with each other and also mechanisms for the management of the coordinated operation of an instance of the logical range. They are presented in a format that provides a description of each core component (information management infrastructure services and core applications). Certain capabilities that are required for complete TENA operation are presented and defined as Mandatory Applications within the TENA Core. A discussion of the TENA architecture as compared to HLA is also provided. The complete technical details of the services (parameters, exceptions, pre and post conditions, use cases) are contained in Appendix C. Full details of the TENA Core will be elaborated via a series of experiments and prototypes which explore and validate architectural concepts. These details will be provided as an update to this document or released independently as part of the continuing exploratory work.

The Standards and Protocols provide for agreements on issues that support architectural requirements. These involve data representation, communications protocols, supporting platform capabilities, and processes. TENA standards activity has been focused on identification of available standards. Selection has been largely deferred to development of system architectures and implementations. Experiments and prototypes will allow us to evaluate candidate selections.

Communications standards are a key area of concern for TENA. TENA has supported a modest test of the applicability of ATM technologies, specifically between Edwards Air Force Base and China Lake. A report of this is provided in Volume X. Additional efforts to categorize representations of open air range data, transfer characteristics, and potential standards is also under way at NAWC, China Lake. Results will be incorporated into a revision of this document.

This document is intended for use by system developers, component designers, and other interested parties.

Volume V - Logical Range Business Process Model

The Logical Range Business Process Model (LRBPM) is intended to provide the reader with a process definition of how to conduct a test or training exercise in the Logical Range environment. The Logical Range concept implies that facilities or test and training ranges are no longer restricted to local assets or resources. Technology alone will not achieve the goal of enabling the multi-site and multi-service Logical Range environment. Management and cultural changes will be needed as well. As a result, the planning, scheduling, execution and reviewing phases of a test or training exercise conducted in a Logical Range environment call for common procedures and processes that could enable a cost and time efficient concept of operations and yield the same (or increased) flexibility when creating exercises to meet warfighter test and training needs.

The LRBPM outlines and defines the steps and activities to be followed when conducting a Logical Range test or training exercise. In conjunction with the Test and Training ENabling Architecture (TENA) it supports the Logical Range Concept of Operations. The LRBPM defines a process that could be manual, semi-automated, or fully automated as it is transitioned into the test and training community. Full implementation of the LRBPM relies on the utilization of browser-based technology such as the Logical Range Support Tool.

In addition to the process definition the LRBPM report identifies architectural requirements such as data products, operations and services. It presents implementation issues which facility users, e.g., acquisition managers, training coordinators, test directors, and program managers will need to address in the multi-site/multi-service environment. Finally, it recommends subsequent actions for process validation, model refinement, and implementation.

The Logical Range Business Process Model (LRBPM) provides the reader with a definition of how to conduct a test or training exercise in the Logical Range environment. The Logical Range is a set of assets required to conduct a specific test or training event logically assembled into a system. The assets may come from one or more facilities. The ability to conduct a test or training exercise in a Logical Range environment means that test and training ranges, and facilities are no longer restricted to their local assets or resources. The Logical Range crosses physical and Service boundaries to achieve seamless interoperability, sharing and reuse of resources. To achieve the goal of enabling the multi-site, and multi-Service Logical Range environment, management and cultural changes will be needed. As a result, all phases of building and using the Logical Range call for common procedures and processes to enable a cost and time efficient capability to meet warfighter test and training needs.

The LRBPM defines a process that could be manual, semi-automated, or fully automated as it is transitioned into the test and training community. In conjunction with the Test and Training ENabling Architecture (TENA) Technical Reference Architecture (TRA), it supports the TENA Application Concepts. The LRBPM offers a broad view of the exercise development. It commences with the input of customer requirements and ends when all data and financial issues are closed. The LRBPM relies on the utilization of browser-based technology proposed in the Logical Range support tool for full implementation. Development of this tool will be done following the Product Line Approach as discussed in Volume II of the TENA Baseline Report.

In addition to the process definition, the LRBPM report presents implementation issues which facility users, e.g., acquisition managers, training coordinators, test directors, and program managers will need to address in the multi-site/multi-Service environment. Finally, it recommends subsequent actions for process validation, model refinement, and implementation.

Volume VI - TENA Application Concepts

An *application concept* is the name given to a group of methods or procedures which show how to use architecture components to solve primary customer needs.

TENA defines three application concepts:

- The *Logical Range Application Concept* shows how the TENA Object Model structure and the Logical Range Business Process Model work together to respond to the increased demand for multiple-site exercises and/or exercises which cross T&E/training or live/virtual/constructive boundaries.
- The *Systematic Reuse Application Concept* shows how the Product Line Approach (PLA) and object-oriented Technical Reference Architecture reduce software development and maintenance costs, support utilization of common instrumentation at multiple facilities, and respond to the increased demand for consistency of information between facilities.
- The *Continuous Insight Application Concept* shows how the customer focused object structure, together with the Logical Range Application Concept, allows for consistency of information across phases of the acquisition process and capturing critical data to support informed customer and management decisions about resource needs, capabilities, and investments.

The Logical Range Application Concept supports high-level requirements for: integrated test and training, re-engineered acquisition process, model and simulation reuse, and exercise complexity and realism. The Logical Range Application Concept description offered demonstrates how the TENA Object Model and Logical Range Business Process Model work together to meet customer requirements.

Concept of Operations for the Logical Range

The conceptual framework for military operations defined in ***Joint Vision 2010*** is of a size, scale, and scope that cannot be physically recreated in an economical manner for testing and training. At the same time, a realistic representation of this battlespace needs to be available to acquisition program managers and to the operational forces tasked with providing and using the information technology needed to coordinate and implement the envisioned operational concepts. The answer proposed by DoD is the development of the capability to engineer a Joint Synthetic Battlespace. This Concept of Operations (CONOPS) expands upon the vision of a Synthetic Battlespace to discuss how it might function in reality to meet the complex needs associated with major weapons system acquisition while still supporting a broad training agenda.

Acquisition-related Test and Evaluation (T&E) requirements, which specify exacting data collection and real-time performance, and Training requirements, which specify complex coordination of large-scale distributed force levels, are the most demanding synthetic capability requirements. The CONOPS responds to the challenge of this demand with the concept of a "Logical Range". The Logical Range, modeled on the functionality of current instrumented ranges, will allow any user to identify requirements and satisfy them through the dynamic networking and interoperability of physical and synthetic assets throughout the test and training community. The technologies that make the dynamic composability of the Logical Range possible will also respond to the cost, time, and safety issues that can frustrate current range operations.

Facilities will be able to create partnerships to create synergistic services.

The Logical Range concept and its related supporting standards will ensure that existing or newly developed synthetic products, usually models or simulations, incorporate the properties necessary to ensure multi-purpose and DoD-wide interoperability. Existing physical ranges will be vital Logical Range nodes or sites, interacting with both synthetic products and other physical ranges. All participants are envisioned as being equally capable of configuring a Logical Range for a specific purpose. Likewise each will independently contribute to the development of a range configured for a more sophisticated or wider scope Joint arena battlespace. All are equal in partnership in both developing and employing the Logical Range concept.

It is intuitive to envision the use of physical and synthetic products to create a joint battlespace environment but more difficult to define how that battlespace might operate and to define its required capabilities. This CONOPS is provided to seek inputs and validation from the Acquisition, T&E, and Training communities. It is crucial that these communities find that the proposed Logical Range concept offers capabilities that are needed and prove cost effective to use. Following conceptual validation, pilot programs with associated Measures of Effectiveness/Measures of Performance (MOE/MOPs) can be identified by the services to further refine the concept, develop realistic cost experiences, assess the adequacies of technologies, and highlight needed supporting policies.

Volume VII - Integrated Validation and Verification Plan

There are established guidelines for verifying and validating system properties. [IEEE, 86] These guidelines propose the following definitions:

- Verification: The process of determining whether or not the products of a given phase of the software development cycle fulfill the requirements established during the previous phase
- Validation:. The process of evaluating software at the end of the software development process to ensure compliance with software requirements.

In layman's terms, verification answers the question: "Did I build the product correctly, according to the specification?" Validation answers the question: "Did I build the correct product, according to its intended use?"

TENA is a project to develop a common architecture in support of test and training applications. The objectives of this architecture are support of interoperability among ranges, reuse of range software, and sharing of test information. Products of the TENA project include the common architecture and a capability to support generation of range systems for individual test or training exercises.

For TENA, verification is a process including review, inspections and tests that will demonstrate conformance of the common architecture and other products to TENA requirements. Validation for TENA will include demonstration that range systems can be built using TENA products.

This plan outlines the steps to be followed in the process of verification and validation of TENA.

There are established guidelines for verifying and validating system properties. [IEEE, 1986] These guidelines propose the following definitions:

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In layman's terms, verification answers the question: "Did I build the product correctly, according to the specification?" Validation answers the question: "Did I build the correct product, according to its intended use?"

The Test and Training ENabling Architecture (TENA) is a project to develop a common architecture in support of test and training applications. The objectives of this architecture are support of interoperability among facilities, reuse of software, and sharing of information. TENA products include the Technical Reference Architecture

(TRA) and the Logical Range Business Process Model (LRBPM). These provide a capability to dynamically assemble resources for individual test or training exercises.

For TENA, verification is a process including review, inspections and tests that will demonstrate conformance of the common architecture and other products to TENA requirements. Validation for TENA will include demonstration that operational systems can be built using TENA products. This process consists of four phases explained in the Integrated Validation & Verification Plan.

Volume VIII- Transition Plan

The Test and Training ENabling Architecture (TENA) Project Transition Plan is designed to support transition of the architecture to the services and DoD agencies. It identifies transition responsibilities, presents a transition process, discusses the stakeholders, identifies some issues and concerns, and provides recommendations about management and oversight. The fundamental acceptance of the Product-Line Approach (PLA) is key to the successful implementation of the TENA architecture. The range community can accomplish significant movement towards major objectives of reduction, restructuring, and revitalization by implementation of the architecture alone, but these gains will be short-lived without a well-planned strategy for life-cycle support. The PLA is the fundamental key to enable necessary increases in range productivity and to maintain or improve that productivity over time.

Range architectures to date have been range-centric, meaning that the focus has been on the environment, facilities, sensors, processors, and analysis systems, rather than on the customer and his individual exercise requirements. We have always tried to make the test or exercise fit the range, rather than the other way around. Now, with advances in networking and computing technology and a new architecture, we can meet the requirements of customers better and test smarter using a concept called the "logical range." TENA introduces a new customer-focused architecture.

A transition process based upon the Product-Line Approach is presented here. Architecture life-cycle supportability issues are addressed, as are concerns with transition management and oversight. The Transition Plan will be updated to reflect new concepts learned through discussions with the sponsor, users, and range communities.

This process begins with prototypes of TENA in a scenario-based analytical phase and a controlled pilot concept exploration in FY98. Successful testing of critical features of the architecture will reduce implementation risk. During FY99 an operational testing phase is expected to support delivery of the system architecture ready for installation at one or more DoD selected ranges or facilities for parallel operational testing. This testing will culminate in FY00 with the establishment of a TENA-compliant operational system.

The Test and Training ENabling Architecture (TENA) Project Transition Plan is

designed to support transition of the Architecture to the Services and DoD agencies. It identifies transition responsibilities, presents a transition process, discusses the stakeholders, identifies some issues and concerns and provides recommendations about management and oversight. The fundamental acceptance of the PLA is key to the successful implementation of the TENA architecture. The range community can accomplish significant movement towards major objectives of reduction, restructuring, and revitalization by implementation of the architecture alone, but these gains will be short-lived without a well planned strategy for life-cycle support. The PLA is the fundamental key that can enable necessary increases in range productivity and to maintain or improve that productivity over time.

The fundamental difference with the TENA Architecture is that it is a customer focused view of the problem. Range architectures to date have been range-centric, meaning that the focus has been on the environment, facilities, sensors, processors, and analysis systems, rather than on the customer's individual exercise requirements. We have always tried to make the test or exercise fit the range, rather than the other way around. Now, with advances in networking and computing technology and a new architecture, we can meet the requirements of customers more effectively and test smarter using a concept called the "logical range". TENA introduces a new paradigm and a new way of doing business.

A transition process, based upon the Product-Line Approach is presented here. Architecture life cycle supportability issues are addressed, as are transition management and oversight concerns. The Transition Plan will be updated to reflect new concepts learned through discussions with the sponsor, users and range communities.

This process begins with prototypes of TENA in a scenario-based analytical phase and a controlled pilot concept exploration in FY98. Successful testing of critical features of the architecture will reduce implementation risk. During FY99 an operational testing phase is expected to support delivery of the System Architecture ready for installation at one or more DoD selected ranges or facilities for parallel operational testing. This testing will culminate in FY00 with the establishment of the Product-Line Approach.

Volume IX - Glossary of Terms and Definitions

The Glossary of Terms and Definitions provides detailed definitions of terms related to TENA, the Test and Training communities, and related technical data. It is intended to be used as a reference while reading all TENA volumes, since we do not include a glossary in each individual volume of the report.

Volume X - Other Supporting Information

The TENA Baseline Project Report Supporting Information Volume contains various reports and documents related to the overall project. These are research efforts, procedural and documentation guides, and other studies that support the development of the project or project deliverables. This volume is meant to be used as a companion when reading Volumes I through X. The documents provided in this volume are in alphabetical order as seen in the Table of Contents. Al electronically available documents will be posted to the TECWEB (http://tecnet1.jcte.jcs.mil:8200/) and the TENA homepage (http://c38.npt.nuwc.navy.mil/TENA/).